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RELATIONSHIP BETWEEN METAVERSE CRYPTOCURRENCIES (META COINS) AND SUSTAINABILITY INDICES

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Servet Say[1], Mesut Dogan[2]
[1]Selcuk University, Department of Accounting and Taxation, Vocational School of Social Sciences, Konya, Türkiye.
servetsay@selcuk.edu.tr , ORCID: 0000-0003-4216-6650
[2]Bilecik Seyh Edebali University, Department of Finance, Banking And Insurance, Bozuyuk Vocatinal School, Bilecik, Türkiye.
mesut.dogan@bilecik.edu.tr , ORCID: 0000-0001-6879-1361

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ABSTRACT

Purpose- The purpose of this study is to determine the relationship between metaverse and sustainability indices. MANA token was used as a metaverse indicator in the study. Dow Jones Sustainability Emerging Markets Index (DJS_EMI), Dow Jones Sustainability World Index (DJS_WI), Dow Jones Sustainability Europe Index (DJS_EI) were used as sustainability indices.

Methodology- In this research, the dynamic relationships between Metaverse and 3 sustainable indices used in the study were analyzed with a time-varying parameter vector autoregressive (TVP-VAR) model. This method is based on the fixed parameter sliding window VAR approach, first developed by Antonakakis and Gabauer (2017) and later updated by Diebold and Yılmaz (2009, 2012, 2014).

Findings- DSJ_EMI variable carries a volatility spread of 24.85% to "DSJ_WI", 24.81% to "DSJ_EI" and 25.40% to "METAVERSE". "DSJ_WI" has a 59.68% volatility spread to other variables. The variables "DSJ_EMI" 25.04%, "DSJ_EI" 25.10% and "METAVERSE" 24.69% carry out volatility spread. Finally, while 70.79% of the volatility change in the "METAVERSE" variable is due to itself, a total of 29.21% is due to other variables. The variables "DSJ_EMI" 9.74%, "DSJ_WI" 9.74% and "DSJ_EI" 9.73% perform volatility spread.

Conclusion- Mana (Decentraland Token) is the cryptocurrency used in the virtual reality platform called Decentraland. Metaverse refers to a digital universe called virtual reality, augmented reality and virtual world. Decentraland is a decentralized virtual reality platform that allows users to create, trade and interact with their own digital content.As a result of the analysis, it was determined that MANA, a Metavarse crypto asset, spreads volatility to sustainability indices. In other words, the MANA token spreads volatility to sustainability indices.

Keywords: Metaverse, metaverse cryptocurrincies, meta coins, sustainability ındex, TVP-VAR
JEL Codes: C32, C55, C58

1. INTRODUCTION

Firstly, Neal Stephenson mentioned the concept of Metaverse in his science fiction novel "Snow Crash". The author, who describes an unreal virtual universe in the novel, explains that people can survive in the virtual universe as well as in the real world. The virtual universe (Metaverse) provides its users with an endless space where they can spend all their time, shop, have fun, have meetings, meet new people, and create their own avatars. In this world, which is a virtual universe, users are free. External factors affecting the individual such as laws, rules, traditions, cultural characteristics, prohibitions, diseases, psychological pressures and family ethics that affect the daily life of individuals in the real world are no longer an obstacle in the virtual universe run by artificial intelligence, thus encouraging users to spend time in the virtual universe. For example, NFT art galleries are one of Metaverse's most popular service offerings. It can be purchased with Ethereum on OpenSea, one of the NFT markets, by clicking on the desired artwork. The currency used to buy and sell digital real estate in Decentraland's Metaverse is "MANA". As the variety of services offered to users in the digital environment increases, the cryptocurrencies used and non-fungible token (NFT) transactions will also increase.

The concept of sustainability has become very popular today. In its most general definition, the concept of sustainability means meeting both economic and social needs while also taking into account the needs of future generations. This means

not consuming existing resources unconsciously while meeting today's needs. The most important issue in this process is the efficient and effective use of environmental factors (Yürek et al., 2021: 1). The increasing importance of sustainability over time has also revealed the need for businesses to act more sensitively and more transparently about the impacts and results of the environmental, social and governance dimensions of their activities, and has made businesses aware of their responsibilities towards a wide segment of society (Wilson, 2003: 2-3). However, it is observed that, as a result of the dramatic degradation of the environment due to overuse of natural resources and high levels of pollution that harm the well-being of future generations, businesses have become more determined to contribute to sustainable development and engage in activities consistent with sustainability. Businesses have also begun to realize the benefits of disseminating their environmental and social activities to their stakeholders (Pereira et al., 2021: 63).

The aim of this research is to determine the relationship between metaverse and sustainability indices. MANA token was used as a metaverse indicator in the study. Dow Jones Sustainability Emerging Markets Index (DJS_EMI), Dow Jones Sustainability World Index (DJS_WI), Dow Jones Sustainability Europe Index (DJS_EI) were used as sustainability indices. Daily frequency data covers the periods 10.11.2020-10.11.2023 for all variables. In the study, time-varying parameter vector autoregressive (TVP-VAR) model was used.

2. LITERATURE REVIEW

The prominent studies in the literature on the subject that attract attention are summarized below.

Nadini et al. (2021) analysed a large dataset including 6.1 million trades of 4.7 million NFTs in 160 cryptocurrencies, primarly Ethereum and WAX, and covering the period between June 23, 2017 and April 27, 2021. Finally, they investigated the predictability of NFT sales using simple machine learning algorithms and find that sale history and, secondarily, visual features are good predictors for price.

Aharon and Demir (2021) analyzed the relationship between returns for non-fungible tokens (NFTs) and other financial assets during the period from January 2018 to June 2021. By using the Time-Varying Parameter Vector Autoregressions (TVPVAR) approach, they showed that the relationship between the returns for financial assets increased during the COVID-19 period. As a result of the analysis, they determined that NFTs are independent of shocks from common assets and diversification is beneficial in times of crisis.

Dowling (2021) analysed the pricing of parcels of virtual real estate in Decentraland, showing that the price series of these NFTs are characterised by inefficiency and a rise in value. Dataset is all secondary market trades in Decentraland LAND tokens from the period March 2019 to March 2021.

Ante (2022) investigated the interrelationships between NFT sales, NFT users, and the pricing of Bitcoin (BTC) and Ether (ETH). Dataset are composed of Daily price between January 2018 and April 2021. The results showed that a Bitcoin price shock triggers an increase in NFT sales. Also, Ether price shocks reduce the number of active NFT wallets. Moreover, cryptocurrency markets affect the growth and development of the NFT market, but there is no reverse effect.

Sönmezer and Çelik (2022) investigated the structure of returns on metaverse tokens. The dataset are composed of 394 daily observations of various cryptocurrency returns for the sample period between 27 December 2020 to 27 January 2022. MANA, ENJ, THETA, and AXS are chosen as representatives from the metaverse world and Bitcoin and Ethereum coins are chosen from the crypto world. The results showed that these tokens are positively influenced by their rival tokens' returns as well as their trading volumes. For MANA returns, ENJIN returns have a positive 99% statistical significance but for ENJIN returns, MANA, THETA, AXS, and ETH returns have a positive 99% statistical significant effect.

Yılmaz and Ecemiş (2022) wanted to determine the digital marketing capabilities of the identified Metaverse platforms in relation to the marketing mix components by examining data obtained from the crypto currency exchange "Binance" and the "Intotheblock" website. The sample of the study are the Metaverse platforms with a complete dataset for the criteria determined operating on the "Binance" and "Intotheblock" platforms operating in the crypto currency exchanges, "Aavegotchi (GHST), Axie Infinity (AXS), Decentraland (MANA), Illuvium (ILV), My Neighbor Alice (ALICE), The Sandbox (SAND) and Smooth Love Potion (SLP)". According to the results obtained with the CoCoSo method, the success order of Metaverse platforms is MANA, SAND, GHST, AXS, SLP, ALICE and ILV.

Vidal-Tomás (2022), analysed the performance and dynamics of market price movements of 84 metaverse tokens and 129 play-to-earn tokens over a period between 28 October 2017 and 31 October 2021 and found positive performance though characterized by high volatility. Moreover, the financial performance of metaverse and play-to-earn tokens could not be justified by the real evolution of NFT sales and investor attention.

Sahay et al. (2022) focused on how the Metaverse can affect the business models of companies and the growth of their economies. The authors used econometrics models such as ARIMA and SARIMAX to predict the stock prices of four Metaverse cryptocurrencies like AXS, MANA, SAND and ILV based on their performance during March 2021 to March 2022 and reported an increase in the investment. The results are an indicator for the potential growth of the respective company's cryptocurrency token, which in turn is proportional to the growth of the company in the market.

Akkuş et al. (2022) wanted to investigate the existence of price bubbles in MANA, the meta coin of the Decentraland digital reality platform, which has the largest market value among meta coins. For this purpose they used the newly developed GSADF multiple bubble test. According to the result of the analysis carried out with the GSADF test, the existence of price bubbles in MANA prices in different periods has been determined.

Nakavachara and Saengchote (2022) addressed to the returns to LAND investment using real estate analyses such as hedonic pricing regressions and price indices. By examining repeat sales they can more accurately assess whether purchasing and reselling LAND is a good investment in different denominations.

Pamucar and Biswas (2023) aims to provide a framework to compare the metaverse crypto assets based on their market performance. A novel hybrid framework such as Logarithmic Percentage Change driven Compromise Solution based Appraisal are used in the study. According to the results, the momentum of the closing prices and volatility of the price movements hold the higher importance as derived by calculation of objective weights. The comparison of the results obtained by LOPCCSA with other Multi Criteria Decision Making (MCDM) models show considerable consistency. The sensitivity analysis indicates that LOPCCSA provides a stable solution.

3. DATA AND METHODOLOGY

The aim of this study is to determine the relationship between metaverse and sustainability indices. MANA token was used as a metaverse indicator in the study. Dow Jones Sustainability Emerging Markets Index (DJS_EMI), Dow Jones Sustainability World Index (DJS_WI), Dow Jones Sustainability Europe Index (DJS_EI) were used as sustainability indices.

MANA token is the meta coin of the Decentraland digital realty platform. In other words, MANA is the local cryptocurrency of the Decentraland project and allows users to buy and sell digital assets in a virtual realty environment. Since Decentraland is a platform that uses blockchain technology to create and manage a virtual reality world, MANA is a tool used to trade digital assets within this metaverse of Decentraland. The DJS_EMI index is an index created based on the financial performances of companies operating in emerging markets, the DJS_WI index is based on the financial performances of large and sustainability-oriented companies around the world, and the DJS_EI index is based on the financial performances of sustainability-oriented companies in Europe.

The DJS_EMI, DJS_WI and DJS_EI variables used in the study were obtained from the internet addresses "www.spglobal.com" and the MANA variable was obtained from the internet addresses "www.coinmarketcap.com". Closing data sets at daily frequency cover the periods 10.11.2020-10.11.2023 for all variables. Data sets of variables were converted into return series with the formula ln(Pt/Pt-1)*100, and then volatility series were obtained by taking the squares of the return series.

In this research, the dynamic relationships between Metaverse and 3 sustainable indices used in the study were analyzed with a time-varying parameter vector autoregressive (TVP-VAR) model. This method is based on the fixed parameter sliding window VAR approach, first developed by Antonakakis and Gabauer (2017) and later updated by Diebold and Yılmaz (2009, 2012, 2014). The TVP-VAR model is as follows (Antonakakis and Gabauer, 2017; Akkuş and Doğan, 2023; Doğan et al., 2023):

$$Y_t = \beta_t Y_{t-1} + \epsilon_t \qquad \epsilon_t | F_{t-1} \sim N(0, S_t) \tag{1}$$

$$\beta_t = \beta_{t-1} + v_t \qquad v_t | F_{t-1} \sim N(0, R_t) \tag{2}$$

The total connectedness index is calculated as follows (Antonakakis and Gabauer, 2017):

$$C_t^g(J) = \frac{\Sigma_{i,j=1,i\neq j}^{N} \tilde{\phi}_{ij,t}^g(J)}{\sum_{i,j=1}^{N} \tilde{\phi}_{ij,t}^g(J)} * 100 \tag{3}$$

$$= \frac{\Sigma_{i,j=1,i\neq j}^{N} \tilde{\phi}_{ij,t}^g(J)}{N} * 100 \tag{4}$$

The situation called "total directional connectivity to others", where variable i transmits its shock to all other variables j, is as follows;

$$C_{i\rightarrow j,t}^{g}(J) = \frac{\Sigma_{j=1,i\neq j}^{N} \tilde{\phi}_{ji,t}^{g}(J)}{\sum_{j=1}^{N} \tilde{\phi}_{ji,t}^{g}(J)} * 100 \quad (5)$$

The situation called "total indirect connectivity from others", which variable i contains from other j variables, is as follows;

$$C_{i\leftarrow j,t}^{g}(J) = \frac{\Sigma_{j=1,i\neq j}^{N} \tilde{\phi}_{ij,t}^{g}(J)}{\sum_{i=1}^{N} \tilde{\phi}_{ij,t}^{g}(J)} * 100 \quad (6)$$

"Net total directional connectedness", which can be interpreted as the "strength" of variable i or its effect on the network of all variables, is obtained by subtracting the total directional connectedness from the others as follows::

$$C_{i,t}^{g} = C_{i\rightarrow j,t}^{g}(J) - C_{i\leftarrow j,t}^{g}(J) \quad (7)$$

4. FINDINGS

In this part of the study, dynamic connectivity relationships between the variables used are investigated with the TVP-VAR model. First of all, the time path graphs of the price series of the variables are shown below in Figure 1.

Figure 1: Price Series Graphs of Variables

When the price series graphs of the DJS_EMI, DJS_WI and DJS_EI variables in Figure 1 are examined, it is understood that it peaked in 2021. These variables started to decline at the end of 2022 and started to rise again in 2023.

Figure 2: Volatility Series Graphs for Variables

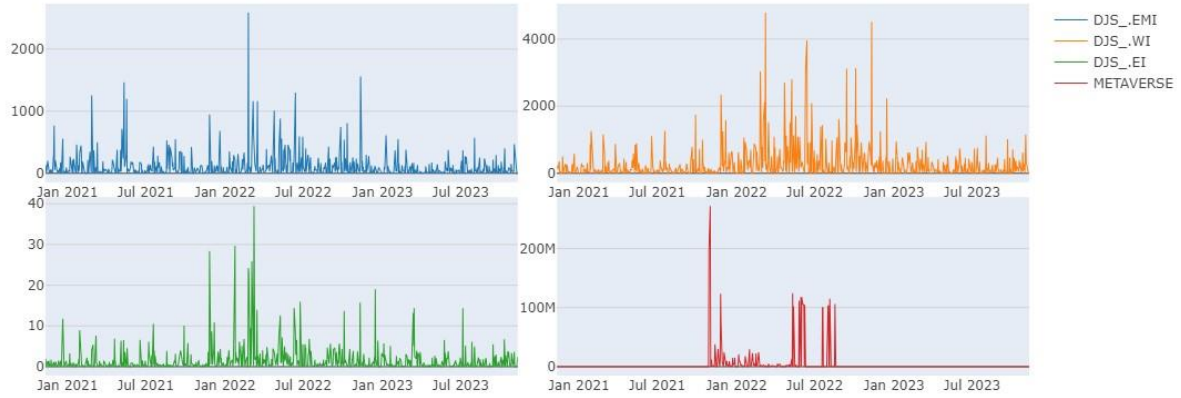

Figure 2 shows the volatility series graphs of the variables. DJS_EMI, DJS_WI and DJS_EI have the highest volatility in 2022. In addition, volatility is highest in the METAVERSE variable in the January-June period of 2022.

Table 1: Descriptive Statistics of Volatility Series of Variables

	DSJ_EMI	DSJ_WI	DSJ_EI	METAVERSE
Mean	108.058	264.458	1.599	3616881.546
Skewness	5.099***	4.552***	5.491***	7.526***
Kurtosis	40.281***	28.273***	41.190***	68.065***
Jarque-Bera	55897.504***	28562.864***	58833.391***	157323.750***
ERS	-10.786***	-10.337***	-8.949***	-8.876***
Q(10)	27.410***	47.321***	62.813***	183.051***
Q2(10)	7.851	13.800**	48.241***	117.426***
Observation	778	778	778	778
ADF	-15.163***	-21.266***	-33.742***	-41.635***

Table 1 shows descriptive statistics of the volatility series for the variables used in the study. Additionally, as a result of the Jargue-Bera test, it was determined that the variables were not normally distributed. According to the ADF unit root test results, it is understood that that the series of first differenced values of variables are stationary.

Figure 3: Dynamic Total Connectivity Relationship of Variables

Figure 3 shows the dynamic connectedness relationship between variables. According to the results, there is a lot of volatility spread among the variables until the end of 2021. However, after this period, the dynamic interconnectedness between these variables partially decreased and remained stable.

Figure 4: Net Total Directional Connectivity Relationship of Variables

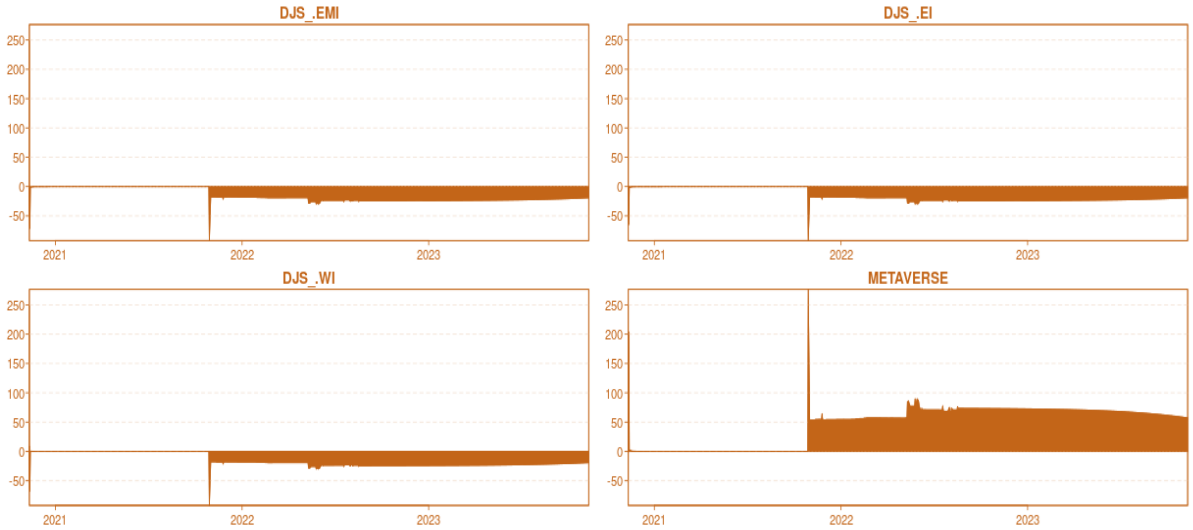

Figure 4 shows the net total directional connectivity results with the TVP-VAR model. The shaded areas below the zero point show the volatility pickup in the corresponding date or period, and the shaded areas above the zero point show the volatility spread in the corresponding date or period. According to the results, the variables "DJS_EMI", "DJS_WI" and "DJS_EI" are volatile. However, the "METAVERSE" variable spreads volatility in all periods.

Table 2: Average Dynamic Connectivity Relationship of Variables

	DSJ_EMI	DSJ_WI	DSJ_EI	METAVERSE	FROM
DSJ_EMI	24.94	24.85	24.81	25.40	75.06
DSJ_WI	25.06	25.14	25.08	24.72	74.86
DSJ_EI	25.04	25.10	25.17	24.69	74.83
METAVERSE	9.74	9.74	9.73	70.79	29.21
TO	59.85	59.68	59.62	74.81	253.97
NET	-15.21	-15.18	-15.21	45.60	84.66/63.49

Table 2 shows the average dynamic connectivity results of the variables during the analysis period. While 24.94% of the volatility change in the "DSJ_EMI" variable is due to itself, a total of 75.06% is due to other variables. DSJ_EMI variable carries a volatility spread of 24.85% to "DSJ_WI", 24.81% to "DSJ_EI" and 25.40% to "METAVERSE". On the other hand, "DSJ_EMI" has a 59.85% volatility spread to other variables. Accordingly, "DSJ_EMI" is a variable with a net volatility of 15.21%.

While 25.14% of the volatility change in the "DSJ_WI" variable is due to itself, a total of 74.86% is due to other variables. The variables "DSJ_WI" 25.06%, "DSJ_EI" 25.08% and "METAVERSE" 24.72% perform volatility spread. On the other hand, "DSJ_WI" has a 59.68% volatility spread to other variables. Accordingly, "DSJ_WI" is a variable with a net volatility of 15.18%.

While 25.17% of the volatility change in the "DSJ_EI" variable is due to itself, a total of 74.83% is due to other variables. The variables "DSJ_EMI" 25.04%, "DSJ_EI" 25.10% and "METAVERSE" 24.69% carry out volatility spread. On the other hand, "DSJ_EI" has a volatility spread of 59.62% to other variables. Accordingly, "DSJ_WI" is the variable with a net volatility of 15.21%.

Finally, while 70.79% of the volatility change in the "METAVERSE" variable is due to itself, a total of 29.21% is due to other variables. The variables "DSJ_EMI" 9.74%, "DSJ_WI" 9.74% and "DSJ_EI" 9.73% perform volatility spread. On the other hand, it has a volatility spread of 74.81% to other variables in the "METAVERSE". Accordingly, the "METAVERSE" variable is the variable that has a net volatility of 45.69%.

Figure 5: Network Graph of Volatility Spread of Variables

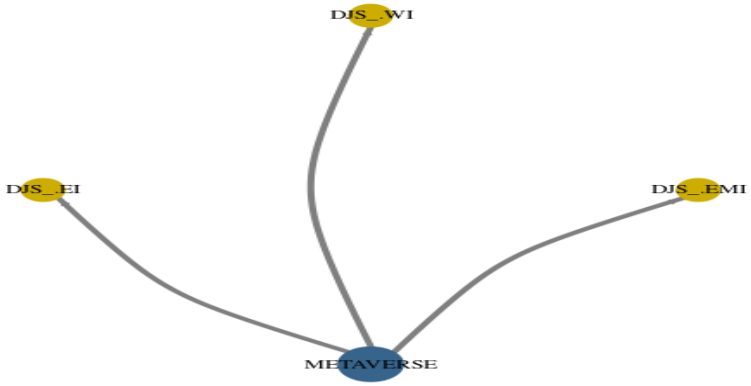

Figure 5, presented as a network graph, shows the variables containing volatility spreads between volatility series. Blue circles represent variables that spread volatility, while yellow circles represent variables that spread volatility. In addition, the size of the circles indicates the size of the spillover effect. Accordingly, while "METAVERSE" is the variable that spreads volatility, "DJS_EMI", "DJS_WI" and "DJS_EI" are the variables that spread volatility to itself. In other words, the “METAVERSE” variable spreads volatility to the “DJS_EMI”, “DJS_WI” and “DJS_EI” variables. The arrows in the chart show the direction of the volatility spread and the thickness of the lines with the arrows show the strength of the volatility spread. Accordingly, the “METAVERSE” variable spreads volatility equal to other variables.

5. CONCLUSION

Mana (Decentraland Token) is the cryptocurrency used in the virtual reality platform called Decentraland. Metaverse refers to a digital universe called virtual reality, augmented reality and virtual world. Decentraland is a decentralized virtual reality platform that allows users to create, trade and interact with their own digital content. Mana tokens are used to buy land on the Decentraland platform, sell virtual properties, buy and sell virtual items, and support activities on the platform. Therefore, Mana is a tool used in the content and economic transactions of the Decentraland platform and is used to facilitate trade and interactions within the Metaverse.

In this study, the relationship between metaverse crypto assets and sustainability indices was determined. MANA token was used as the metaverse indicator. Dow Jones Sustainability Emerging Markets Index, Dow Jones Sustainability World Index, Dow Jones Sustainability Europe Index were used as sustainability indices. Data from the periods 10.11.2020-10.11.2023 were used in the study. TVP-VAR method was used in the study. As a result of the analysis, it was determined that MANA, a Metavarse crypto asset, spreads volatility to sustainability indices. In other words, the MANA token spreads volatility to sustainability indices.

This study which examines the dynamic connectivity relationship between metaverse crypto assets and sustainability indices, has a number of limitations. First of all, the findings are valid for the MANA token and the relevant period. New studies with different crypto assets are needed to better understand the relationship between Metevarse and sustainability. Additionally, in future studies, investigating the relationships between new crypto assets such as NFT and DeFi and sustainability indices and clean energy indices will contribute to the literature.

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